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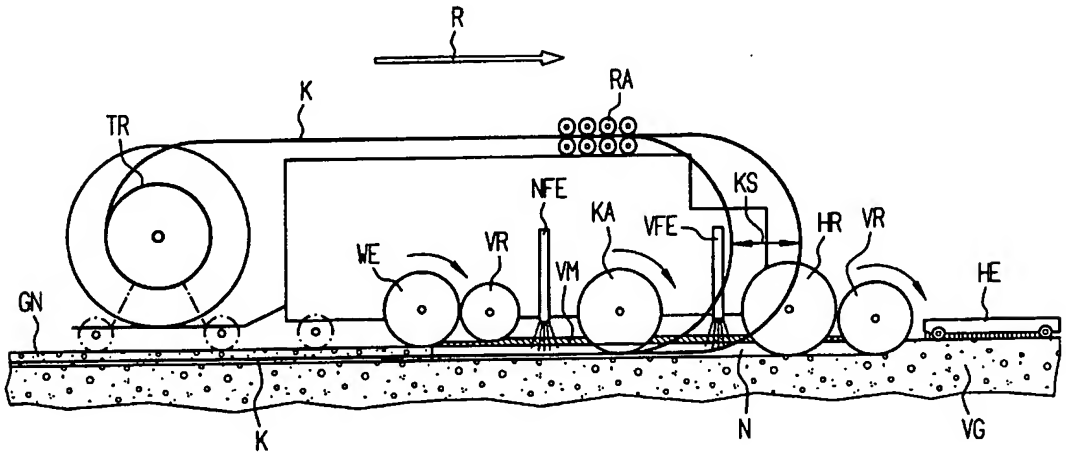
(54) **PROCEDE DE POSE DE CABLES OPTIQUES OU ELECTRIQUES EN SOL FERME ET APPAREIL A POSER DE TELS CABLES**

(54) **PROCESS FOR INTRODUCING AN OPTICAL OR ELECTRICAL CABLE INTO SOLID GROUND, AND MACHINE FOR LAYING THE CABLE**



(57) L'invention a trait à un procédé de pose de câbles, en particulier de microcâbles, en sol ferme. Le procédé fait appel à un appareil servant à former un canal dans un revêtement de surface chauffé du sol ferme en déplaçant le sol. Après l'installation du câble, le canal est rempli au moyen du sol déplacé pour réaliser le canal.

(57) The invention relates to a process for introducing a cable, in particular a microcable, into solid ground, a channel-forming unit being used to produce a channel in the heated top course of the solid ground by virtue of displacing ground material. Once the cable has been introduced, this channel is refilled with the ground material displaced during production of the channel.

GR 97 P 1207

Abstract

Process for introducing an optical or electrical cable into solid ground, and machine for laying the cable.

The invention relates to a process for introducing a cable, in particular a microcable, into solid ground, a channel-forming unit being used to produce a channel in the heated top course of the solid ground by virtue of displacing ground material. Once the cable has been introduced, this channel is refilled with the ground material displaced during production of the channel.

Figure 1

GR 97 P 1207

Description

Process for introducing an optical or electrical cable into solid ground, and machine for laying the cable.

The invention relates to a process for introducing an optical or electrical cable, comprising a homogeneous and pressurized-water-tight tube and optical or electrical conductors introduced therein, into solid ground.

It is known that cables, in particular microcables which comprise a tube with optical waveguides running loosely therein, are laid in solid ground. For this purpose, channels are cut into the structure of a road, footpath or cyclepath and said cables are laid in these channels, fixed therein and covered by appropriate filling material for protection purposes. However, the production of the channels in solid ground such as concrete or asphalt by a cutting operation with the aid of a corresponding cutting machine involves relatively high outlay since it is necessary to go to considerable lengths to dispose of the cut material. Moreover, there is considerable harm to the environment as a result of the dust formation. A further disadvantage of such laying processes which use a channel cut deep in the basic structure of solid ground, such as that of a road, is that, in some circumstances, a "predetermined breaking point" is even created. It is thus necessary to ensure that, as far as possible, the base course of a road is not damaged.

The object of the present invention, then, is to find a process for laying cables in channels of solid ground in the case of which, on the one hand, the cable is sufficiently protected against damage but, on the other hand, the base course of the solid ground is not weakened, the intention being for the channel to be produced, as far as possible, in a straightforward and environmentally friendly manner. The set object is achieved, then, according to the invention, by a process

of the type explained in the introduction, in that a heating unit is used to heat the ground surface until the latter softens, in that a channel-forming unit is used to introduce a channel into the heated ground by virtue of displacing ground material, the ground material which is displaced to the ground surface forming a ridge along at least one channel border, in that a laying unit is used to introduce the optical or electrical cable into the channel, in that a filling unit is used to reintroduce the displaced ground material into the channel, on top of the cable which has been introduced, and in that a rolling unit is used to compact the ground material which has been reintroduced into the channel.

The object of the invention is also to provide a laying unit for carrying out the process. This set object is achieved according to the features of Patent Claim 22.

Advantages of the process according to the invention are, inter alia, that the channel which is necessary for the operation of laying the cable is introduced in the wearing course of the ground rather than, as has been the case up until now, in the base course of the ground as well. In this way, the base course remains undamaged and there is no longer any risk of crack formation. Furthermore, it is not necessary for the channel to have clearly defined channel borders, as are produced during cutting, and this has the advantage that the material which is introduced at a later stage for the purpose of refilling the channel bonds more easily with the original structure. The invention, then, forms a channel by virtue of the top course of the ground being displaced, the material which is broken up or displaced during the formation of the channel being brought to the ground surface, where it is deposited or forms a ridge along at least one longitudinal border of the channel. During the formation of the channel, a counterpressure is expediently produced from above, with the aid of supporting elements, on both sides of the resulting channel, and this counterpressure prevents the channel from being excavated too far to the sides.

Stabilization of the excavated ground material prevents this material from moving away in an undesired manner or from sliding back into the channel which has been formed. Once the channel has been formed, the cable, or the tube of the cable, is immediately laid in the base of the channel. Thereafter, the ground material which has been displaced and deposited at the sides is then reintroduced into the channel, on top of the cable which has been laid therein, and compacted by an appropriate rolling unit. Any air inclusions, cavities, irregularities or locations where there is a lack of material are closed off with filler, for example bitumen, granules of ground material or epoxy. This means that such a mechanically strong cable, in particular a microcable, is laid in solid ground, for example a road, so as to be watertight over its length, a continuous frostproof road surface being restored as a result of the process. This makes it possible to dispense with the use of hot bitumen as filler and sealant, as has been necessary in the case of the previous processes. It is also the case that the process according to the invention does not involve any abrasion dust which has to be disposed of. Moreover, the original ground structure is maintained. Surface, appearance, strength and loading capacity of the ground surface are not changed in any way. The channel for the operation of laying the cable is introduced only in the wearing course or surface course of the ground, for example in the wearing course of an asphalt road, with a depth of from approximately 2 to 3 cm, at most to the depth of the thickness of the top course of the ground. This channel depth is fully sufficient for reliable laying of a microcable which has a tube with an external diameter of from 2 to 15 mm. The optical waveguides of this microcable are introduced into the interior of the tube either before or after the tube is laid. After the laying operation, the ground material which has been reintroduced, rolled in and compacted provides the cable itself with sufficient protection from above against mechanical loading and damage.

The channel is produced by virtue of ground material being displaced with the aid of appropriate channel-forming units, which are forced or pressed into the ground material which has already been preheated by heating elements. In this case, the ground material which has been displaced and also possibly broken up is brought from the channel which has been formed to the road surface, where it is "thrown up" in a ridge-like manner. If the grain size of the ground filler is too large for the broken-up ground material to be displaced to the road surface, the channel-forming unit may, if required, be made to vibrate vertically. In this case, relatively large pieces of rock or filling means are then crushed. Moreover, the vibration assists the flow behaviour of the ground material. Additional, horizontal vibrations may reduce the friction between the pressing-in tool of the channel-forming unit and the channel wall. For this purpose, a plurality of synchronously running eccentric discs are fitted on the frame of the channel-forming unit.

However, the necessary channel may also, according to the invention, be introduced in the heated ground with the aid of a carriage, in the case of which, for example, an oscillating runner is pressed under high pressure and drawn in the direction of travel. Such a process would correspond approximately to a ploughing operation. However, it is also possible to use a ram which forces depressions into the ground from above at very high frequency. This makes it possible, with minimal pressing-in pressure, for any types of channel shapes, bores and also changes in channel direction with very small radius to be forced in, the ground material likewise being displaced in each case.

It is advantageous if all the units of the individual process steps are combined, preferably via appropriate couplings, to form a complete laying and pressing-in unit, which can then be moved by self-propulsion or traction along the cable-laying route in the operating direction. Such a laying and pressing-in

unit comprises the following functions:

- heating the ground surface with the aid of a heating unit
- introducing the channel with the aid of a channel-forming unit
- introducing cable into the channel and holding down said cable with the aid of a laying unit
- filling the channel, with the aid of a filling unit, with ground material which has been displaced and deposited at the sides of the channel
- restoring the ground surface with the aid of a rolling unit.

The successive process steps are explained in more detail hereinbelow.

First of all, the ground surface is cleaned with the aid of a sweeper machine, for example with a conventional road sweeper. However, such a road sweeper could also be integrated in the laying and pressing-in unit. An appropriate suction-extraction machine disposes of the dirt which has been picked up from the street, with the result that the channel which is to be produced is not contaminated.

The ground surface is then heated, with the aid of heating units, in the region of the channel which is to be produced, such that the ground material, for example the asphalt surface, softens. This heating operation, however, has to take place gradually since, with excessive heating, the material may be damaged in some circumstances. Use is thus made, for example, of heating pads which are known in road construction and are used for repair work when the surface course of the road, rather than being cut away, is merely intended to be heated and consolidated again by rolling. These heating pads are operated by propane gas and have dimensions of approximately 1 x 1 m or 2 x 2 m. For the heating unit according to the invention, for example a plurality of heating elements are arranged in a row one behind the other up to a length of approximately 10 m. The ground surface is heated gradually thereby and, for the produc-

tion of the channel, it is possible to reach advancement rates of up to 3 km/hour. For this purpose, the width of these heating elements is expediently from 0.3 to 0.5 m. The heating elements of this heating unit run on rollers and are connected to one another, for example, via couplings. As a result, the entire heating unit is steerable and, if required, it can turn. However, it would also be possible for the heating unit to be kept shorter if, for example, the channel-forming unit is heated in addition.

Once the top course of the ground has been heated sufficiently to the depth of the channel which is to be produced, the channel-forming unit is lowered or inserted. This channel-forming unit may be designed as a roller-type or carriage-type tool. The first-mentioned embodiment comprises one or more rollers arranged one behind the other to form a roller arrangement. The diameters and thicknesses of the rollers are graduated in order that the operations of making the channel wider and deeper take place gradually. The entire channel-forming unit can be lowered, preferably by hydraulic mechanisms. In principle, the rollers do not have to be driven, heated or made to vibrate, but such additions can be retrofitted, if required, for special functions or special cases. Thus, it is also possible to make use of a channel-forming unit which can produce a plurality of channels one beside the other at the same time. For the normal service-life requirement, the rollers are produced from case-hardened steel. For more stringent requirements, for example with a high proportion of rock in the ground, it is also possible to use hard-metal rollers. The roller arrangement is configured such that it can be exchanged easily and quickly if required. If a plurality of rollers are combined one behind the other to form a roller arrangement, then the shape of the rollers is such that the first roller penetrates slightly into the ground surface by wedge action; in contrast, the flanks of the last roller are approximately right-angled in order to form a precise channel flank. The rollers may be, for

example, of rectangular cross-section or of at least partly conical cross-section.

During production of the channel using a roller-type tool of the kind described, the channel border may crack in an undefined manner. This is to be expected particularly in the case of relatively old, damaged road surfaces. In order, however, to obtain a defined channel width, it is expedient for supporting elements, for the example in the form of supporting rollers, to be arranged on both sides of the channel-forming unit, these supporting elements acting from above, as the channel is formed, on the ground surface and thus preventing any further cracking of the surface at the sides. It is also expedient using these supporting elements, or an additional forming unit, for the ground material which has been displaced from the channel formed to be stabilized temporarily along the channel borders, until refilling takes place, in order to prevent backsliding.

Immediately after the channel-forming unit has formed the channel, a laying unit is used to introduce the optical or electrical cable into the channel, to be precise the microcable is drawn off from the accompanying cable drum and is introduced into the channel. A cable guide ensures that the cable is guided in a defined manner, and an accompanying roller holds down the cable in the base of the channel. Immediately before and/or after the cable is introduced into the channel, it is possible for the channel wall to be provided with an appropriate adhesion promoter, for example a primer, for improving adhesion and, in some circumstances, with liquid bitumen as an adhesive, and binder, for the filling material which is to be reintroduced.

Once the cable has been introduced into the channel, the ground material which has been deposited and displaced along at least one channel border is brought together by a filling unit, for example by a hopper-like collector, and brought into the channel. A rolling means in the form of a compacting roller rolls the introduced ground material into the channel and compacts it again.

Once the channel has been refilled and the ground material which has been introduced is compacted by the compacting roller, the ground surface, for example the road surface, can be restored. For a fine-grain surface, it is possible for the top side of the channel to be mixed with granules, for example consisting of ground material such as asphalt. If the volume of the broken-up ground material is not sufficient for filling the channel, it is also possible, in addition, to introduce filler, rolled bitumen or granules together with bitumen or an adhesive. Any cavities can be sealed by binders such as bitumen or epoxy. Using a following levelling roller, the channel surface is levelled off with the ground surface.

This concludes the laying operation using the process according to the invention.

It is expedient to combine the individual units to form a complete pressing-in and laying unit, with the result that the latter can be transported, for example, on a low loader. For any transportation overseas, the functional units can be uncoupled and shipped individually in units, for example in standard containers.

Overall, the process according to the invention provides considerable advantages in comparison with the prior art. Producing the channel by a displacement operation, rolling-in operation or by breaking up the wearing course of the ground can achieve very quick laying rates, for example up to 30 m/minute. This is a considerably higher laying rate than in the case of the process which uses joint cutting. The novel process can thus be used to lay from approximately 20 to 30 km of a cable, e.g. a microcable, in one day. It is also advantageous that the heat which is used for heating up the ground surface is available as residual heat in order, once the cable has been laid, for the material which has been displaced and deposited as a ridge to be rolled in, this residual heat being sufficient for compacting the reintroduced material to a sufficient extent.

Furthermore, it is of no consequence as to

whether, in the case of the process according to the invention, the sides of the channel produced are smooth and regular. It is even the case that the irregularities which are produced during the breaking-up operation for forming the channel have a favourable effect since the irregularities bond well with the reintroduced ground material. In addition, there is no need for any device for holding down the laid cable since the operations of filling the channel and compacting the introduced material take place immediately after the cable has been laid. It is also advantageous that the ground material which has been displaced and removed is deposited, and stabilized, at the sides, along the longitudinal borders, the forming unit serving, at the same time, to support the ground in the upward direction at the sides, in order that any further, undesired cracking of the surface at the sides is prevented. Up until now, the grooves have been sealed with hot bitumen, but this is not necessary in this process. The design of the cable, having a tube as outer sheathing, makes it possible for the radial pressure to be absorbed in full. It is also possible for reinforcements, which further enhance the strength, to be rolled in together with the cable. For changes in direction, it is possible for arcuate formations to be pressed into the ground surface, these having to be designed such that they are not exceeded by the minimum permissible bending radius of the cable. Moreover, the laying operation can be carried out irrespective of the weather.

The process according to the invention is also very environmentally friendly because there is no need for any waste disposal or the disposal of rubble or excavated material. Moreover, the original road structure is not changed; in particular, there is no intervention in the base course of the ground, for example in the concrete substructure of a road. As a result, the predetermined strength of the road remains. A "predetermined breaking point" in the base course of the ground, as is produced, in some circumstances, during cutting, is not produced here. Since, for the purpose of forming the

channel, the ground material is brought to the surface at the sides, over-compaction of the roadway directly beneath the channel, as is the case with other processes, is avoided. It is also advantageous that the temperatures of from 80° to 120°C which are required for the laying operation are far below those which are used for filling with hot bitumen (260°C). Moreover, the laying operation takes place with considerably less energy consumption and a considerably reduced level of noise, since the cutting noise is eliminated.

This laying method may also be used for roadway renewal, when the roadway surface is reinforced with glass-fibre mats or when roadway markings or roadway reinforcements are rolled on at the side of the roadway. It is then possible for fibres to be incorporated directly in the glass-fibre mats or the sides of the roadway. As binder and filling material, it is also possible to use, in addition to bitumen, thermosetting epoxy, which can be provided with colour in order to be seen more clearly.

The cable can also be more easily concealed since it is embedded at a smaller depth and is only concealed by a thin covering. Even for the concealing operation, there is no special waste which has to be disposed of separately. It is also advantageous that the bitumen of an asphalt surface is not subjected to any thermal damage during the gradual heating-up operation before the channel is introduced.

The machine for laying a cable by this process also has particular advantages since the operations of pressing in, laying the cable, filling and consolidating take place one after the other. It is expedient for the road surface to be cleaned before the operation of pressing in or excavating the channel, the dust being disposed of via a suction-extraction machine in this case. The channel-forming unit with its roller arrangement may be lowered hydraulically, as a result of which the channel depth can be adjusted in a stepless manner. The diameters and widths of the rollers are graduated

with respect to one another, with the result that the operations of making the channel deeper and wider take place gradually. The shape of the flanks of the roller widens as the number of rollers increases. Moreover, the roller shape can be adapted to the desired shape of the channel. In the case of wear or a different roadway composition, the rollers of the roller arrangement can be exchanged easily. The ground material is treated particularly carefully as a result of the gradual heating in a long, narrow heating zone. The heating unit used is steerable, with the result that it can thus turn as well. The heating unit is expediently extended in accordance with requirements by heating pads being arranged in a row. The complete pressing-in and laying unit is expediently self-propelled, and can have further functional units coupled to it.

The process according to the invention also achieves a channel, between the cable and the channel wall, which is watertight over its length, with the result that moisture is reduced and the cavities are minimized. As a result, the entire region is less susceptible to frost. If required, use may be made of bitumen or other filling means and binders which produce an additional bond between the channel border and the reintroduced ground material. Overall, good mechanical strength of the refilled channel is achieved by "wedging" of the reintroduced ground material in the channel wall. In this case, the cable is guided by way of the uniformly surrounding material and is fixed to a sufficient extent even in the event of temperature fluctuations, with the result that it cannot "rise up". The pressing-in operation can be facilitated in addition by an overlaid vibration plate. Moreover, the shape of the rollers of the filling unit is selected such that the displaced ground material is held together, the surface does not crack and the broken-up ground material can be rolled directly into the channel. The adhesion to the channel wall can be increased by the addition of a primer. If, finally, the tube of the laid cable is enclosed by a polyethylene

sheath, the possibly required operation of lifting the cable is simplified since bitumen or primer do not adhere particularly well to this sheath.

The invention will now be explained in more detail with reference to three figures.

Figure 1 shows a basic schematic arrangement of a laying and pressing-in unit according to the invention.

Figure 2 shows the pressed-in channel in the open state with the cable already laid therein.

Figure 3 shows the channel, with the cable laid therein, once it has been closed again.

Figure 1 shows a basic illustration of a laying and pressing-in unit, which may be made up of individual functional units or may be constructed as a complete unit. Expediently, however, the heating unit is independent and can be coupled to the rest of the units in a straightforward manner. The heating unit HE is used to heat the ground VG, in the region of the channel which is to be produced, until the ground softens. Once the softening temperature has been reached, the channel-forming unit acts on the heated ground VG, for example by way of the depicted roller arrangement comprising a preliminary roller VR of smaller diameter and a main roller HR of larger diameter, so as to form a channel. The heated ground VG is displaced in this way, thus forming, to the sides of the rollers VR and HR, ridges which run, as displaced ground material, along the longitudinal borders of the channel. After the channel N has been formed, a roller pull-off RA is used to draw off from the accompanying cable drum TR the cable K which is to be laid, and this cable is laid in the open channel N with the aid of a cable pressure-exerting roller KA. A prefilling means VFE expediently introduces an adhesion promoter into the channel before the cable KA is introduced, so as to improve the adhesion in the channel base. After the cable is introduced, it is also expediently the case for a secondary-filling means NFE likewise to introduce an adhesion promoter, for example a primer or

bitumen, in order to improve the adhesion to the filling material which follows. It can be also be seen in Figure 1 that the displaced ground material VM is deposited as a ridge along the open channel N and emerges from the ground surface. Following this, a filling means is used to close off the channel N, to be precise using the ground material which has been displaced and thrown up to the sides. This takes place by displacement to the sides, using appropriate compacting rollers VR, a hopper or the like, of the ground material formed in a ridge-like manner. Finally, a rolling unit WE is used to compact the ground material which has been reintroduced into the channel and to level this material off with the rest of the ground surface. The final result is the filled channel GN with the cable K laid therein. In the region where the cable is drawn in, a certain cable excess forms a so-called cable store KS, which compensates for the irregularities and tolerances as the laying unit progresses. For reasons of clarity, the arrow R also indicates the laying direction.

Figure 2 illustrates a channel N which has been introduced into the top course OS of the ground VG using the laying unit according to the invention and does not extend into the base course TS of the overall ground structure. This ensures that the base course TS remains undamaged. Figure 2 shows clearly that the operation of pressing in, or forcing in, the channel N produces accumulations of displaced material along the side borders, and these accumulations run along the channel borders as ridges of displaced ground material VM. This illustration shows that the cable K, in particular a microcable having a tube and optical waveguides running therein, has already been introduced.

Figure 3 illustrates that the channel N has already been filled, with the aid of filling, compacting and rolling units, with the ground material VM displaced during the production of the channel, and the filled channel has already been levelled off with the ground surface.

Patent claims

1. Process for introducing an optical or electrical cable, comprising a homogeneous and pressurized-water-tight tube and optical or electrical conductors introduced therein, into solid ground, characterized in that a heating unit is used to heat the ground surface until the latter softens, in that a channel-forming unit is used to introduce a channel into the heated ground by virtue of displacing ground material, the ground material which is displaced to the ground surface forming a ridge along at least one channel border, in that a laying unit is used to introduce the optical or electrical cable into the channel, in that a filling unit is used to reintroduce the displaced ground material into the channel, on top of the cable which has been introduced, and in that a rolling unit is used to compact the ground material which has been reintroduced into the channel.

2. Process according to Claim 1, characterized in that a forming unit is used to stabilize the displaced ground material along the channel.

3. Process according to one of the preceding claims, characterized in that the rolling unit levels off the excess, reintroduced ground material with the ground surface.

4. Process according to one of the preceding claims, characterized in that, during introduction of the ground material, irregularities or locations where there is a lack of material are filled with filler, preferably bitumen, granules of ground material or epoxy.

5. Process according to one of the preceding claims, characterized in that the channel-forming unit is made to vibrate vertically.

6. Process according to one of the preceding claims, characterized in that the ground material is displaced by a channel-forming unit which has a roller arrangement comprising at least one forming roller for channel-forming purposes.

7. Process according to one of Claims 1 to 5,

characterized in that the ground material is displaced by a channel-forming unit which has a carriage, preferably with an oscillating runner, for channel-forming purposes.

8. Process according to one of Claims 1 to 5, characterized in that the ground material is displaced by a channel-forming unit which has a ram which vibrates at high frequency.

9. Process according to one of the preceding claims, characterized in that the heating unit performs the heating operation in a progressively increasing manner, preferably by way of a plurality of individual units guided one behind the other.

10. Process according to one of the preceding claims, characterized in that the channel-forming unit is heated.

11. Process according to Claim 6, characterized in that provided in the roller arrangement of the channel-forming unit are a plurality of rollers which are guided one behind the other and are of different diameters and/or thicknesses.

12. Process according to one of the preceding claims, characterized in that at least the laying unit, with the channel-forming unit, the forming unit and the rolling unit, is lowered or raised hydraulically.

13. Process according to one of the preceding claims, characterized in that, as the channel is formed, the channel borders are prevented from cracking at the sides by accompanying supporting elements, preferably supporting rollers in the forming unit.

14. Process according to one of the preceding claims, characterized in that the cable in the laying unit is drawn off from a cable drum, introduced into the channel by way of a cable guide and fixed by a holding-down device or a cable pressure-exerting roller until the ground material which has been displaced and deposited at the sides is introduced.

15. Process according to one of the preceding claims, characterized in that an adhesion promoter, preferably a primer or bitumen is introduced into the channel by a prefilling unit and/or secondary-filling unit before

and/or after the cable is introduced.

16. Process according to one of the preceding claims, characterized in that the ground material which has been displaced and deposited at the sides, is brought together in the filling unit by a collector, which is preferably designed in the form of a hopper, and is introduced into the channel and compacted by the rolling unit.

17. Process according to one of the preceding claims, characterized in that all the units are combined, preferably via couplings, to form a complete laying and pressing-in unit and can be moved by self-propulsion or traction along the cable-laying route in the operating direction.

18. Process according to one of the preceding claims, characterized in that the channel for receiving the cable is introduced into the top, asphalt course of the ground.

19. Process according to one of the preceding claims, characterized in that a microcable comprising a tube with an external diameter of from 2 to 15 mm, and optical waveguides introduced loosely therein, is introduced into the channel in the ground.

20. Process according to one of the preceding claims, characterized in that the channel in the ground is produced with a depth of from 2 to 3 cm, at most to the depth of the thickness of the top course of the ground.

21. Process according to one of the preceding claims, characterized in that the cable is drawn off from the accompanying cable drum by a caterpillar pull-off with storage excess between the caterpillar pull-off and the holding-down device or the pressure-exerting roller.

22. Machine for introducing a cable into solid ground using the process of Claims 1 to 21, characterized in that the machine has a heating unit for heating the ground surface in the region of the channel which is to be introduced, a channel-forming unit for forming the channel by virtue of displacing ground material, a laying unit for drawing off from the cable drum the cable which is to be laid and for introducing the cable into the channel and for holding down said cable, a filling unit

for introducing the displaced ground material, and a rolling unit for compacting and closing off the channel with previously displaced ground material.

23. Machine according to Claim 22, characterized in that the channel-forming unit contains at least one roller in a lowerable roller arrangement.

24. Machine according to Claim 22, characterized in that the channel-forming unit has at least one carriage runner, preferably a vibrating runner, for forming the channel.

25. Machine according to Claim 23, characterized in that the rollers are of rectangular cross-section.

26. Machine according to Claim 23, characterized in that the rollers are of at least partly conical cross-section.

27. Machine according to one of Claims 22 to 26, characterized in that a cable excess is formed between a cable pull-off, preferably a caterpillar pull-off, and the point where the channel is introduced.

28. Machine according to one of Claims 22 to 27, characterized in that the individual functional units are arranged separately from one another, but are connected to one another via couplings.

29. Machine according to one of Claims 22 to 28, characterized in that all the units are connected fixedly to one another to form a single laying and pressing-in unit.

FIG 1

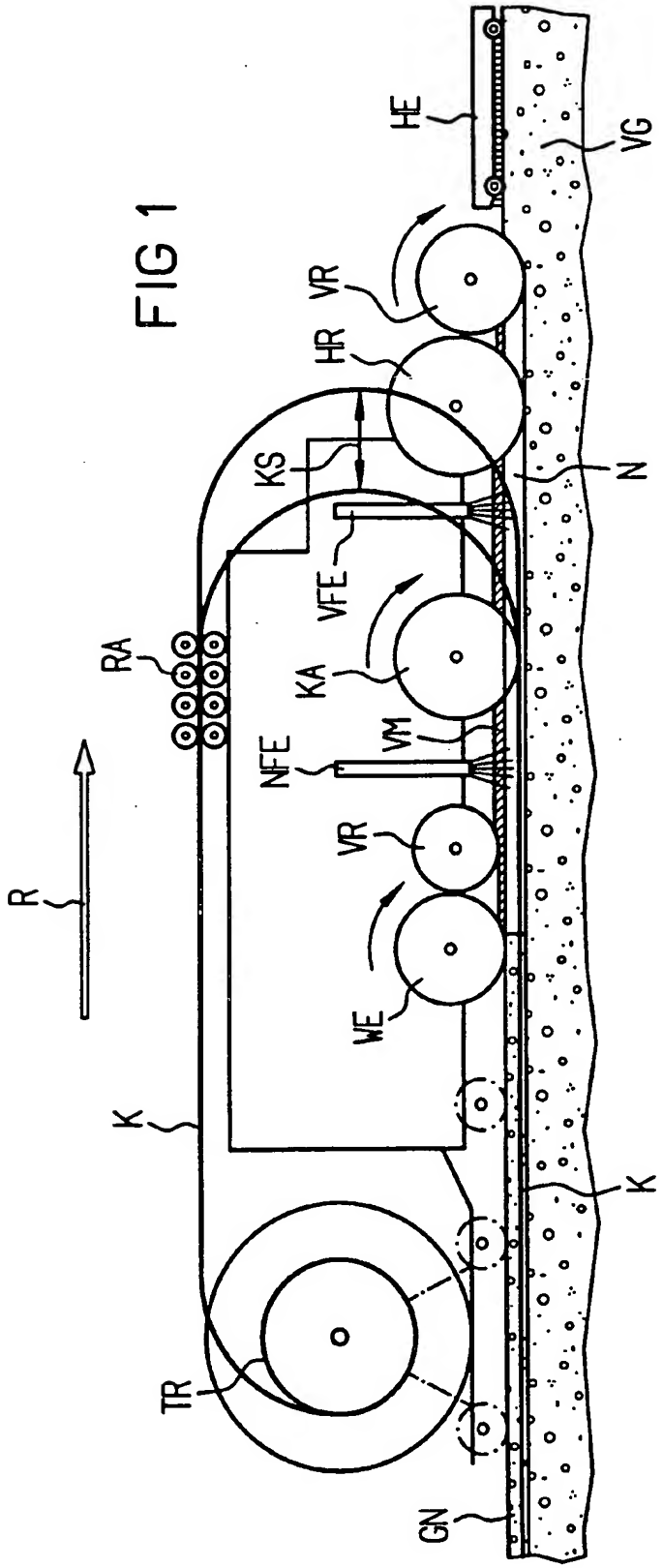


FIG 2

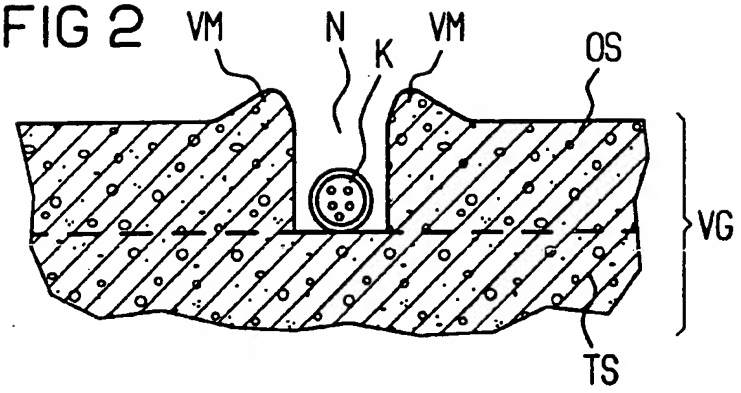
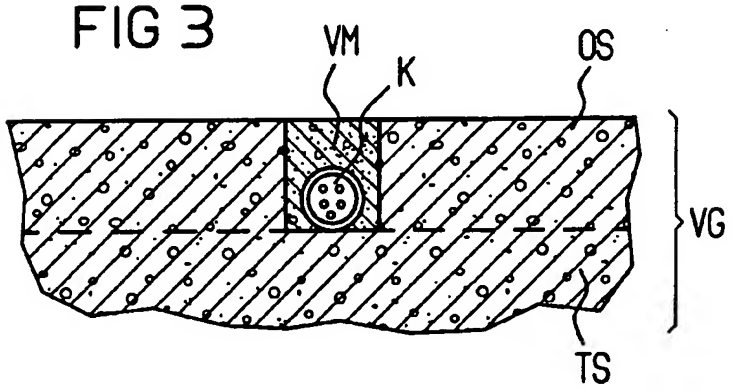


FIG 3



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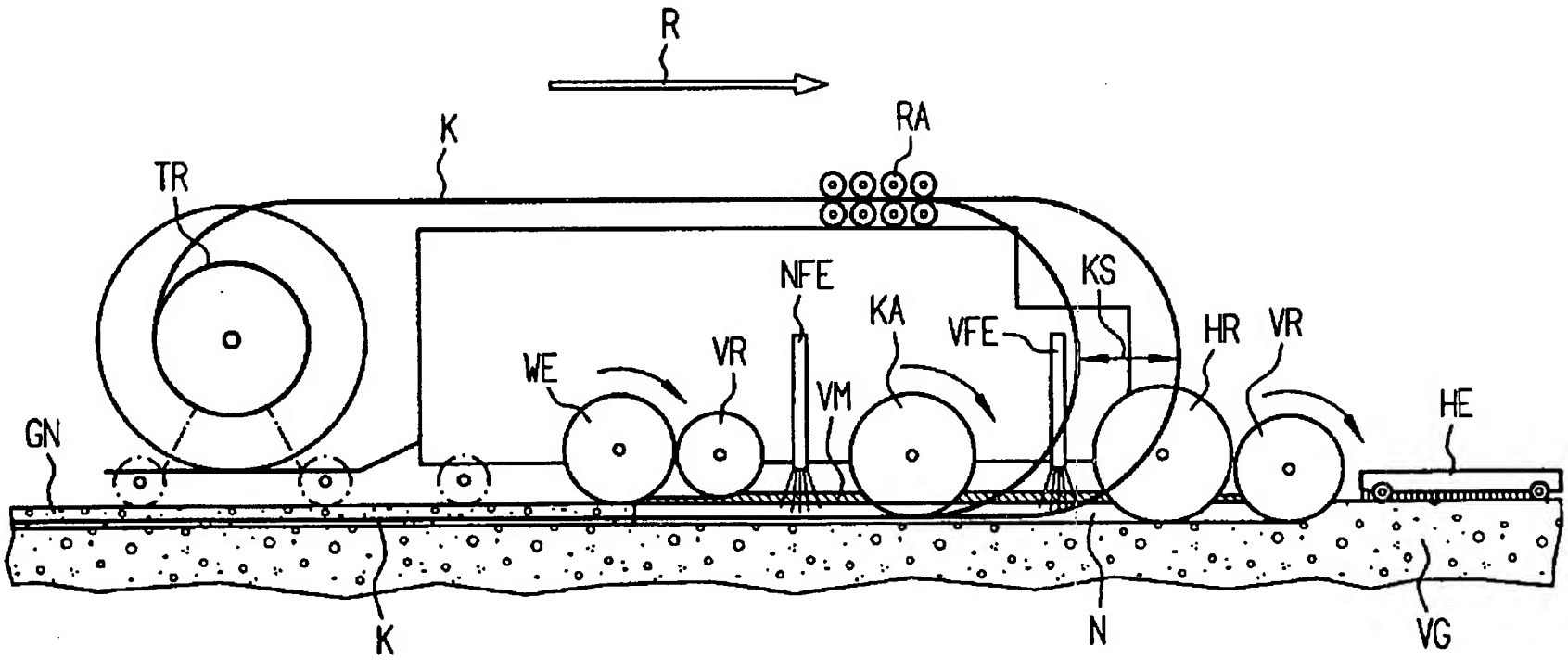
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